特開平10-320126

(19) Japanese Patent Office (JP)

(12) **Patent Office Gazette** (A)

(11) Patent No. 320126/1998 (Heisei 10)

(43) Laid-open date: December 4, 1998

(51) Int. Cl.^{6} Identification Mark FI

G 06 F	3/06	301	G06F	3/06	301Z
		540			540
	12/00	501		12/00	501H
	13/10	340		13/10	340A

Request for examination: not yet

Number of Claim: 8 OL (20 pages in total)

---

(21) Application No. 335488/1997 (Heisei 9)

(22) Application date: December 5, 1997

(31) Priority application number: No. 60566/1997 (Heisei 9)

(32) Priority application date: March 14, 1997 (Heisei 9)

(33) Priority country: Japan

(71) Applicant: 000005223

Fujitsu Limited

4-1-1, Kamikodanaka, Nakahara-ku, Kawasaki-shi, Kanagawa

(72) Inventors:

Kenji KANEKO, Kiyoshi KAWANO, Masanobu SUZUKI,

Toshio FUKUI, Hiroaki YAMAMOTO, Toshiya MURA

c/o Fujitsu Limited, 4-1-1, Kamikodanaka, Nakahara-ku, Kawasaki-shi, Kanagawa

(74) Agent: Patent Attorney, Saichiro MIYAUCHI (and other one person)

(54) [Title of the Invention]

VOLUME ALLOCATION SYSTEM AND MEDIUM WITH VOLUME ALLOCATING PROGRAM RECORDED THEREON

(57) Abstract

[Object] To optimize volume allocation and improve access response and throughput in a volume allocation system having logical volume groups consisting of a plurality of divided logical volumes.

[Constitution] If after an allocation candidate list 37 is created, the listed candidates belongs to a disk array system, logical volume constitution information is acquired from an I/O constitution information managing means 41 with respect to each allocated logical volume. The other logical volumes belonging to the logical volume group containing the allocated volumes are set in an allocated list 38. Logical volume constitution information is acquired from the I/O constitution information managing means 41 with respect to each allocated logical volume. A logical volume having the lowest I/O load is selected from allocation candidate volume groups, and the other logical volumes in the same volume groups are excluded from allocation.

[What Is Claimed Is]

[Claim 1] A volume allocation system which has a disk array comprising a plurality of logical volume groups including a plurality of logical volumes obtained by dividing large-capacity disks and selects a logical volume achieving the minimum I/O response, characterized in that the volume allocation system comprises:

a performance information gathering means which gathers performance information from devices containing said disks;

an I/O constitution information managing means which generates, updates, and notifies logical volume constitution information indicating how a plurality of logical volume groups are constituted of a plurality of said logical volumes with respect to each allocated logical volume;

a constitution information acquiring means which, after an allocation candidate list is created, judges whether the listed candidates belong to a disk array system and, if so, acquires logical volume constitution information from said I/O constitution information managing means with respect to each allocated logical volume;

a setting means which sets the other logical volumes in the logical volume group containing the allocated volume in an allocated list; and

a volume selecting means which acquires logical volume constitution information from said I/O constitution information managing means with respect to each allocated logical volume, selects a logical volume having the lowest I/O load from allocation candidate volume groups, and

excludes the other logical volumes in the same volume groups from allocation.

[Claim 2] The volume allocation system according to Claim 1, characterized in that:

said performance information gathering means computes as a virtual I/O response value a value indexing the I/O access performance of devices containing said disks.

[Claim 3] The volume allocation system according to Claims 1 and 2, characterized in that:

said volume selecting means acquires the virtual I/O response value computed at said performance information gathering means, and adds the virtual I/O response value to the selected logical volume and the other logical volumes in the logical volume group to which the selected logical volume belongs.

[Claim 4] The volume allocation system according to Claim 3, characterized in that:

virtual I/O response values added to volumes selected from among non-disk array volumes and virtual I/O response values added to logical volumes selected in a disk array are made different from each other, and virtual response values added to the other logical volumes in the same logical volume group are also made different.

[Claim 5] A medium which involves a disk array comprising a plurality of logical volume groups including a plurality of logical volumes obtained by dividing large-capacity disks and has a volume allocating program recorded thereon for selecting a logical volume achieving the minimum I/O response,

characterized in that the medium comprises:

a means for gathering performance information from devices containing said disks:

a means for generating, updating, and notifying logical volume constitution information indicating how a plurality of logical volume groups are constituted of a plurality of said logical volumes with respect to each allocated logical volume;

a means for, after an allocation candidate list is created, judging whether the listed candidates belong to a disk array system and, if so, acquiring logical volume constitution information from said I/O constitution information managing means with respect to each allocated logical volume;

a means for setting the other logical volumes in the logical volume group containing the allocated volume in an allocated list; and

a means for acquiring logical volume constitution information from said I/O constitution information managing means with respect to each allocated logical volume, selecting a logical volume having the lowest I/O load from allocation candidate volume groups, and excluding the other logical volumes in the same volume groups from allocation.

[Claim 6] The medium with the volume allocating program recorded thereon according to Claim 5, characterized in that:

said means for gathering performance information computes as a virtual I/O response value a value indexing the I/O access performance of devices containing said disks.

[Claim 7] The medium with the volume allocating program

recorded thereon according to Claims 5 and 6, characterized in that:

said means for selecting volumes acquires the virtual I/O response value computed at said means for gathering performance information, and adds the virtual I/O response value to the selected logical volume and the other logical volumes in the logical volume group to which the selected logical volume belongs.

[Claim 8] The medium with the volume allocating program recorded thereon according to Claim 7, characterized in that:

virtual I/O response values added to volumes selected from among non-disk array volumes and virtual I/O response values added to logical volumes selected in a disk array are made different from each other, and virtual response values added to the other logical volumes in the same logical volume group are also made different.

[Description of the Invention]

[0001]

[Industrial Field of Utilization]

The present invention relates to a volume allocation system and a medium with a volume allocating program recorded thereon wherein large-capacity disks, when used, are divided into a plurality of logical volumes, and thereby the influences of I/O access conflict in logical volume groups is reduced and I/O throughput is improved.

[0002]

When a job is done with a computer, a dataset is created in a disk unit with respect to that job. To expand the space

for the dataset, it is required to select volumes in the disk unit to allocate the volumes for the space for the dataset. At this time, a request is made to select volumes from among the volumes prepared in the computer system for use in arbitrary jobs and allocate the volumes for the space for the dataset. This is designated as non-specific volume request.

[0003]

The volume selecting function of a system selects volumes which can provide the space required for a dataset concerned from among such volumes available. At this time, either of two criteria is applicable to the determination of the order of selection: the size of space for the dataset and input/output load. Where the size of space for dataset is adopted as the selection criterion, a volume having the biggest size for space for dataset is selected. Where input/output load is adopted, a volume lowest in access frequency is selected, for example, by referring to the access frequency information on each volume obtained through measurement by an appropriate method.

[0004]

In an attempt to reduce cost, save space, and enhance access speed and reliability, recent disk units employ the RAID technology. In this context, disk arrays where in large-capacity disks are divided into logical volumes have been brought to market. The development of a volume allocation system and a medium with a volume allocating program recorded thereon wherein volume allocation is

optimized and I/O throughput is improved in a computer system using such a disk array is demanded.

[0005]

[Prior Art].

FIG. 13 illustrates an example of conventional computer systems. In FIG. 13, 101 refers to a host computer, and the host computer 101 is connected with input/output controllers 104 and 105 through channels 102 and 103. The input/output controller 105 is connected with disk units 107 and 108 as input/output devices through a path 106.

[0006]

The input/output controller 104 is connected with a disk array 110 as an input/output device through a path 109. The disk array 110 comprises a plurality of logical volume groups 112 and 113 consisting of a plurality of logical volumes 111 obtained by dividing large-capacity disks. Numeral 114 refers to nonspecific volumes, and a nonspecific volume 114 is requested when a volume is selected and allocated to the space for a dataset concerned. The parenthesized numbers on the left indicate the order of allocation and the numbers on the right refer to average I/O response values.

[0007]

In the host computer 101, a volume allocating program 101A for optimizing volume allocation is installed. FIG. 14 is a drawing illustrating an example of the constitution of the volume allocating program 101A. In FIG. 14, the volume allocating program 101A comprises a job management portion 115, an allocation candidate list 116, an allocated list

117, a volume selecting portion 118, and a performance information gathering portion 119.

[0008]

There are two methods for selecting a nonspecific volume 114 to be allocated: selection based on the space for a dataset and selection based on the I/O performance. If the I/O performance is taken into account for allocation, the job management portion 115 creates an allocation candidate list 116 and an allocated list 117, and requests the volume selecting portion 118 to select a volume. The performance information gathering portion 119 gathers performance information on the accumulated values of number of times of I/O issuance and elapsed time in I/O from an input/output device 120. Then, with respect to the input/output device 120, the performance information gathering portion 119 outputs an average I/O response value for a certain period of time to the volume selecting portion 118. The volume selecting portion 118 refers to the allocation candidate list 116 and the allocated list 117 passed from the job management portion 115. Then, the volume selecting portion 118 selects a volume which minimizes the average I/O response value obtained from the performance information gathering portion 119 at certain time intervals. Subsequently, the volume selecting portion 118 notifies the job management portion 115 of, for example, VOL6 as a selected volume 121. In this case, to prevent allocation from being concentrated on one volume till the next certain time interval, the volume selecting portion 118 adds a certain I/O response value for

one time of nonspecific volume 114 allocation. Then, the volume selecting portion 118 selects a volume having the minimum average I/O response value with the certain I/O response value added. The job management portion 115 creates the allocation candidate list 116 and the allocated list 115, and thereby prevents a certain nonspecific volume 114 from being used in job steps a, b, and c of jobs 122 and 123 in a concentrated manner.

[0009]

FIG. 15 is a flowchart illustrating conventional volume allocation. At Step 101, the job management portion 115 creates an allocation candidate list 116 based on nonspecific volumes 114 to be used in job steps a, b, and c of jobs 122 and 123. For example, VOL1 to VOL10 of nonspecific volumes 114 are set in the allocation candidate list 116.

[0010]

At Step 102, the job management portion 115 sets only allocated volumes in the allocated list 117. For example, VOL1, VOL2, VOL3, and VOL4 are set one by one in the allocated list 117. At Step 103, the volume selecting portion 118 refers to the allocation candidate list 116 and the allocated list 117. Then, the volume selecting portion 118 acquires an average I/O response value for a certain time period from the performance information gathering portion 119 at certain time intervals with respect to the input/output device 120. The volume selecting portion 118 adds a certain I/O response value for certain nonspecific volume allocation, and selects a volume having the minimum average I/O response value with

the certain I/O response value added.

[0011]

At Step 104, the job management portion 115 performs allocation processing to obtain a space in the volume selected by the volume selecting portion 118. At Step 105, it is judged whether the space has been successfully obtained. If so, the volume allocation processing is terminated. If not, the operation goes back to Step 102. As illustrated in FIG. 13, volume allocation proceeds in the order of (1) to (10). In this case, I/O response values are added only to selected volumes. Consequently, a conflict of volumes can be avoided but I/O accesses conflict with one another within the identical volume groups 112 and 113. This is because an attempt is made to simultaneously allocate volumes 111 in the identical logical volume groups 112 and 113.

[0012]

[Problems to be Solved by the Invention]

If a large-capacity disk unit is divided into a plurality of logical volumes in a conventional volume allocation system, a problem can arise. If a plurality of read or write requests occur in the identical logical volume group, a drive conflict occurs, and a plurality of accesses can be processed in parallel.

[0013]

In systems associated with the social system (e.g. bank account system), tasks are set up based on certain performance (I/O response, I/O throughput). Therefore, if the I/O response degrades, the tasks are influenced. To avoid this

problem, disk arrays are provided with large amounts of caches. However, a disk conflict is inevitable in complete random access (e.g. processing in bank account systems) wherein cache hit cannot be expected so much. It is also inevitable in large amounts of sequential processing requiring reading from and writing to disk units. To cope with this, task design and volume layout for performance guarantee are required, and this places a significant burden on system administrators.

[0014]

In conventional allocation logic, the volume selecting portion notifies the job management portion of a volume achieving the minimum I/O response. This I/O response involves the performance of disk arrays, such as advantage to the performance resulting from the effect of caches and disadvantage to the performance resulting from a conflict of logical volumes. Also, in selecting nonspecific volumes in a disk array, a volume achieving the minimum I/O response is judged and selected as a volume having the lowest load, which makes no difference. However, if a request to select conflicts with another in a short time, conventional volume allocation systems pose the following problems:

[0015]

- I/O response values are added only to selected volumes. In case of a disk array, therefore, influences on the performance of accessing logical volumes in the identical group are not considered.
- Added I/O response values are uniform and do not take into

account differences in the access performance of devices, and no difference is made between non-disk array volumes and disk array volumes. Therefore, in the second and following rounds, disk array volumes are overlappingly used like non-disk array volumes.

[0016]

As mentioned above, conventional allocation logic does not consider logical volume group. Therefore, in allocating nonspecific volumes in such a system wherein the nonspecific volumes are arranged in a disk array, a conflict of volumes can be avoided but a conflict of I/O accesses can occur within a logical volume group. This is because an attempt is made to simultaneously allocate volumes in the identical logical volume. (Refer to FIG. 13.)

[0017]

The present invention has been made with these problems associated with the prior art taken into account. The object of the present invention is to provide a volume allocation system and a medium with a volume allocating program recorded thereon wherein in a computer system having a plurality of logical volume groups different in I/O access performance, volume allocation is optimized and thus the response to volume accesses and the throughput can be improved.

[0018]

[Means for Solving the Problems]

To attain this object, the present invention is constituted as illustrated in FIG. 1. According to Claim 1 of the present invention, a volume allocation system which has a disk array

comprising a plurality of logical volume groups consisting of a plurality of logical volumes obtained by dividing large-capacity disks and selects a logical volume achieving the minimum I/O response comprises a performance information gathering means 40 which gathers performance information from devices containing the disks; an I/O constitution information managing means 41 which generates, updates, and notifies logical volume constitution information indicating how a plurality of logical volume groups are constituted of a plurality of the logical volumes with respect to each allocated logical volume; a constitution information acquiring means 36A which, after an allocation candidate list 37 is created, judges whether the listed candidates belong to a disk array system, and, if so, acquires logical volume constitution information from the I/O constitution information managing means 41 with respect to each allocated logical volume; a setting means 36B which sets the other logical volumes in the logical volume group containing the allocated volume in an allocated list 38; and a volume selecting means 39 which acquires logical volume constitution information from the I/O constitution information managing means 41 with respect to each allocated logical volume, selects a logical volume having the lowest I/O load from allocation candidate volume groups, and excludes the other logical volumes in the same volume groups from allocation.

[0019]

According to Claim 2 of the present invention, the performance information gathering means 40 computes as a

virtual I/O response value a value indexing the I/O access performance of devices containing the disks. According to a further aspect of the present invention, the volume selecting means 39 acquires the virtual I/O response value computed by the performance information gathering means and adds the virtual I/O response value to a selected logical volume and the other logical volumes in the logical volume group to which the selected logical volume belongs.

[0020]

According to Claim 4 of the present invention, virtual I/O response values added to volumes selected from among non-disk array volumes are made different from virtual I/O response values added to logical volumes selected in a disk array. Further, virtual response values added to the other logical volumes selected in the identical logical volume group is made to differ. According to Claim 5 of the present invention, a medium which involves a disk array comprising a plurality of logical volume groups consisting of a plurality of logical volumes obtained by dividing large-capacity disks and has a volume allocating program recorded thereon for selecting a logical volume achieving the minimum I/O response comprises a means 40 for gathering performance information from devices containing the disks; a means 41 for generating, updating, and notifying logical volume constitution information indicating how a plurality of logical volume groups are constituted of a plurality of the logical volumes with respect to each allocated logical volume; a means 36A for, after an allocation candidate list 37 is created, judging whether

the listed candidates belong to a disk array system and if so, acquiring logical volume constitution information from the I/O constitution information managing means 41 with respect to each allocated logical volume; a means 36B for setting the other logical volumes in the logical volume group containing the allocated volume in an allocated list 38; and a means 39 for acquiring logical volume constitution information from the I/O constitution information managing means 41 with respect to each allocated logical volume, selecting a logical volume having the lowest I/O load from allocation candidate volume groups, and excluding the other logical volumes in the same volume groups from allocation.

[0021]

According to Claim 6 of the present invention, in the medium with the volume allocating program recorded thereon, the means 40 for gathering performance information computes as a virtual I/O response value a value indexing the I/O access performance of devices containing the disks. According to a further aspect of the present invention, in the medium with the volume allocating program recorded thereon, the means 39 for selecting volumes acquires the virtual I/O response value computed by the means 40 for gathering performance information, and adds the virtual I/O response value to the selected logical volume and the other logical volumes in the logical volume group to which the selected logical volume belongs.

[0022]

According to Claim 8 of the present invention, in the medium

with the volume allocating program recorded thereon, virtual I/O response values added to logical volumes selected in a disk array is made different from virtual I/O response values added to volumes selected from among non-disk array volumes, and virtual response values added to the other logical volumes in the identical logical volume group are also made different.

[0023]

Conventionally, only allocated volumes are excluded from allocation. According to the present invention, the other logical volumes in a logical volume group to which an allocated volume belongs are also excluded from allocation. Thus, a conflict of logical volumes within the identical volume groups 1 to 4 is avoided. In consideration of any coexistence of devices, different in I/O access performance, in a nonspecific volume, a virtual I/O response value indexing the I/O access performance is added and incorporated in allocation. Then, the virtual I/O response value is made different between non-disk array volumes and disk array volumes. Thus, disk array volumes and non-disk array volumes are not overlappingly used similarly.

[0024]

Further, virtual I/O response values are also added to the logical volumes other than an allocated volume in a logical volume group. Thus, a conflict of logical volumes becomes less prone to occur in the identical logical group. As a result, volume allocation is optimized and thus the response to volume accesses and the throughput can be improved.

[0025]

[Preferred Embodiments]

FIG. 2 is a block diagram illustrating an embodiment of the present invention. In FIG. 2, 21 refers to a host computer, and the host computer 21 has channels 22 and 23. The host computer 21 is connected with an input/output controller 26 by paths 24 and 25 through the channels 22 and 23. In the host computer 21, a volume allocating program 27 to be hereinafter described is installed for optimizing volume allocation.

[0026]

The input/output controller 26 is connected with a disk array 29 as an input/output device through a path 28, and the disk array 29 comprises a plurality of logical volume groups 1 to 4. The logical volume groups 1 to 4 are obtained by dividing large-capacity disks into a plurality of logical volumes 30. Each of the logical volumes 30 is constituted across a plurality of data disks 31 to 34 and a parity disk 35. In addition, for example, disks 107 and 108 as illustrated in FIG. 13 are connected as non-disk array volumes though they are not shown in FIG. 2.

[0027]

FIG. 3 is a drawing illustrating an example of the constitution of the volume allocating program 27. In FIG. 3, the volume allocating program 27 comprises a job management portion 36, an allocation candidate list 37, an allocated list 38, a volume selecting portion 39 as a volume selecting means, a performance information gathering portion 40 as

a performance information gathering means, and an I/O constitution managing portion 41 as an I/O constitution information managing means.

[0028]

The job management portion 36 has a constitution information acquiring portion 36A as a constitution information acquiring means and a setting portion 36B as a setting means. The constitution information acquiring portion 36A creates the allocation candidate list 37 based on nonspecific volumes to be used in job steps a, b, and c of jobs 42 and 43. After judging that the listed candidates belong to a disk array system, the constitution information acquiring portion 36A acquires logical volume constitution information from the I/O constitution managing portion 41 with respect to each allocated volume.

[0029]

The setting portion 36B sets allocated volumes and the other logical volumes 30 in the logical volume groups 1 to 4 containing the allocated volumes in the allocated list 38. The performance information gathering portion 40 gathers performance information on the accumulated values of number of times of I/O issuance and elapsed time in I/O from the input/output device 44, and outputs the information to the volume selecting portion 39. Further, the performance information gathering portion 40 has a computing portion 40A for virtual I/O response value, and the computing portion 40A computes a value indexing the I/O access performance as a virtual I/O response value.

[0030]

The I/O constitution managing portion 41 generates logical volume constitution information indicating how a plurality of logical volume groups 1 to 4 are constituted of a plurality of the logical volumes 30 with respect to each allocated logical volume and updates the information. Then, the I/O constitution managing portion 41 notifies the job management portion 36 and the volume selecting portion 39 of the information. The volume selecting portion 39 acquires an average I/O response value for a certain time period from the performance information gathering portion 40 at certain time intervals. Further, the volume selecting portion 39 acquires logical volume constitution information from the I/O constitution managing portion 41 with respect to each allocated logical volume. Then, the volume selecting portion 39 selects a logical volume having the lowest I/O load from allocation candidate volume groups and excludes the other logical volumes in the same volume groups from allocation.

[0031]

Further, the volume selecting portion 39 has an adding portion 39A for adding virtual I/O response values. The adding portion 39A acquires a virtual I/O response value computed by the performance information gathering portion 40. Then, the adding portion 39A adds the virtual I/O response value to a selected logical volume and the other logical volumes in the logical volume group to which the selected logical volume belongs.

[0032]

At this time, a virtual I/O response value y added to logical volumes selected in a disk array is made equal to or different from a virtual I/O response value x added to volumes selected from among non-disk array volumes. A virtual response value z added to the other logical volumes 30 in the identical logical volume groups 1 to 4 is made different (smaller value). For example, x, y, and z are so set that x=y=10 and z=7 or x=10, y=5, and z=2.

[0033]

The job management portion 36 accepts selected volumes 45 selected by the volume selecting portion 39 and performs allocation processing on the space in the selected volumes 45. FIGs. 4(A) to 4(C), 5(A), and 5(B) are drawings explaining nonspecific volume allocation with virtual I/O response value not added. FIG. 4(A) illustrates an example of logical volume constitution information 46 acquired from the I/O constitution managing portion 41 by the volume selecting portion 39.

[0034]

The logical volume constitution information 46 comprises a plurality of logical volume groups 1 to 4 consisting of a plurality of logical volumes 30. The numeric values of 2ms, 3ms, … indicate the I/O response values of the individual logical volumes 30. The volume selecting portion 39 refers to the allocation candidate list 37 and the allocated list 38 and selects a volume having the minimum I/O response value from among those in the allocation candidate list 37 other

than the allocated volumes.

[0035]

VOL1 whose I/O response value is 2ms, the lowest value in the logical volume group 1, is allocated as illustrated in FIG. 4(A). Then, VOL1 and the other volumes VOL2, VOL3, VOL4 in the logical volume group 1 to which VOL1 belongs are classified under volume group 47 excluded from allocation and set in the allocated list 38, as illustrated in FIG. 4(B). Then, the allocation candidate volume group 48 under which the logical volume groups 2, 3, and 4 are classified is acquired as logical volume constitution information 46.

[0036]

Next, VOL9 whose I/O response value is 6ms, the lowest value, is allocated as illustrated in FIG. 4(B). Then, logical volume groups classified under volume group 47 excluded from allocation are the logical volume groups 1 and 3, as illustrated in FIG. 4(C). Logical volume groups classified under allocation candidate volume group 48 are the logical volume groups 2 and 4. Next, VOL5 whose I/O response value is 10ms, the lowest value, is allocated as illustrated in FIG. 4(C). Then, logical volume groups classified under volume group 47 excluded from allocation are the logical volume groups 1, 3, and 2, as illustrated in FIG. 5(A). Only the logical volume group 4 is classified under allocation candidate volume group 48.

[0037]

VOLD whose I/O response value is 15ms, the lowest value in the logical volume group 4, is allocated as illustrated

in FIG. 5(A). Then, logical volume groups classified under allocation candidate volume group 47 are the logical volume group 1 without VOL1, the logical volume group 2 without VOL5, the logical volume group 3 without VOL9, and the logical volume group 4 without VOLD, as illustrated in FIG. 5(B). VOL1, VOL5, VOL9, and VOLD are classified under volume 49 excluded from allocation. Thereafter, logical volumes 30 having the lowest I/O response value in the logical volume groups 1 to 4 are allocated in succession again. Eventually, the 16 logical volumes 30 are classified under volume 49 excluded from allocation.

[0038]

FIGs. 6(A) to 6(C), 7(A), and 7(B) are drawings explaining nonspecific volume allocation with virtual response values added. Like FIG. 4(A), FIG. 6(A) illustrates logical volume constitution information 46 acquired from the I/O constitution managing portion 41 by the volume selecting portion 39. The volume selecting portion 39 refers to the allocation candidate list 37 and the allocated list 38 and allocates VOL1 whose I/O response value is 2ms, the lowest value, based on the logical volume constitution information 46.

[0039]

As illustrated in FIG. 6(B), the logical volume group 1 is classified under volume group 47 excluded from allocation, and the logical volume groups 2, 3, and 4 are classified under allocation candidate volume group 48. To the allocated volume VOL1, "10" is added as a virtual I/O response value.

Further, "7" is respectively added as a virtual I/O response value to the other logical volumes VOL2, VOL3, and VOL4 in the logical volume group 1 to which VOL1 belongs.

[0040]

Thus, the virtual I/O response value added to the other volumes VOL2 to VOL4 ("7") is set to a value lower than the virtual I/O response value added to the allocated volume VOL1 ("10"). Next, as illustrated in FIG. 6(C), "10" is added as a virtual I/O response value to the allocated volume VOL9 (6ms) in the volume group 3, and "7" is respectively added as a virtual I/O response value to the other volumes VOLA, VOLB, and VOLC in the logical volume group 3.

[0041]

Next, as illustrated in FIG. 7(A), "10" is added as a virtual I/O response value to the allocated volume VOL5 (10ms) in the logical volume group 2, and "7" is respectively added as a virtual I/O response value to the other volumes VOL6, VOL7, and VOL8 in the logical volume group 2. Next, "10" is added as a virtual I/O response value to VOLD (15ms) in the logical volume group 4 in FIG. 7(A), and "7" is respectively added as a virtual I/O response value to the other volumes VOLE, VOLF, VOL0 in the logical volume group 4.

[0042]

As illustrated in FIG. 7(B), logical volume groups classified under allocation candidate volume group 48 are the logical volume group 1 without VOL1, the logical volume group 2 without VOL5, the logical volume group 3 without VOLC, and the logical volume group 4 without VOLD. VOL1,

VOL5, VOL9, and VOLD are classified under volume 49 excluded from allocation, and have "10" added as a virtual I/O response value thereto, respectively. VOL2 to VOL4, VOL6 to VOL8, VOLA to VOLC, and VOLE to VOL0 have "7" added as a virtual I/O response value thereto, respectively. Then, logical volumes 30 having the lowest I/O response value in the logical volume groups 1 to 4 are allocated in succession again. Eventually, the 16 logical volumes 30 are classified under volume 49 excluded from allocation, and the volume allocation processing is terminated.

[0043]

FIG. 8 is a drawing illustrating the order of volume allocation. In FIG. 8, the logical volume group 1 contains four divided logical volumes 30. The I/O response value of the logical volumes 30 are respectively 5ms, 5ms, 6ms, and 11ms. The logical volume group 2 contains four divided logical volumes 30. The I/O response values of the logical volumes 30 are respectively 6ms, 6ms, 7ms, and 8ms.

[0044]

107 and 108 respectively refer to a disk arranged not in disk array. 50 refers to nonspecific volumes. In case the volumes are allocated without adding virtual I/O response values, the allocation process proceeds in the order of (1) to (16). As a result, a conflict of I/O accesses becomes less prone to occur in the logical volume groups 1 and 2. Next, the virtual I/O response value added by the volume selecting portion 39 will be described.

[0045]

With respect to nonspecific volumes, there is a possibility that devices different in access performance coexist in an allocation candidate group. Further, there is such a type of nonspecific volume that a volume is divided into logical volumes. To cope with this, indexes are provided to indicate the following two points. Thereby, future I/O response values resulting from allocation are predicted, and a criterion for allocation is established. The virtual I/O response value is provided as this index value:

- The access performance varies from one input/output device to another.

[0046]

- In case nonspecific volumes are divided into logical volumes, any conflict between the divided volumes leads to degradation in performance. Intrinsically, it is impossible to predict an I/O response value at the time of allocation. This is because the amount of I/O accessing is unknown at this time. Therefore, a certain value with the access characteristic of devices taken into account is added as a virtual I/O response value.

[0047]

I/O processing time and number of times of I/O issuance are accumulated with respect to each device. As the actual performance for the past 10 seconds, an average I/O response value is computed, and the virtual I/O response value is added to the thus computed value. Thus, an I/O response value after allocation is predicted, and a volume lowest in this value is selected from unallocated devices in nonspecific

volume allocation.

[0048]

Predicted I/O response value = average I/O response value for past 10 seconds + virtual I/O response value

In a disk array, a logical volume conflict occurs in logical volume groups, and this causes degradation in performance. To cope with this, such allocation logic as to avoid allocation within the identical logical volume group as much as possible should be employed. In this case, virtual I/O response values can be used as follows:

[0049]

It is assumed that:

Value for allocated non-disk array volume = x,

Value for allocated disk array volume = y, and

Value for unallocated volume in logical volume group containing allocated disk array volume = z.

[0050]

If it is assumed that x=y and z<x, the object will be attained. For example, we can set x=y=10 and z=7. If a difference is to be made in priority in allocation between disk array volumes and non-disk array volumes, we can set x>y>z. At this time, x, y, and z can be determined if the relative performance value of the disk array volumes relative to the non-disk array volumes is known.

[0051]

In general, the I/O access performance (I/O response) depends mainly on the following factors:

(1) Characteristics of I/O Access

- Sequential access, random access
- Read, write (update, creation)

(2) Amount of I/O Accessing

- Small-amount accessing, large-amount accessing

(3) Hardware Performance

- Cache hit performance
- Cache miss performance

(4) I/O Load and Conflict Factor

- Conflict of device path
- Conflict of logical volume
- Conflict of channel and internal resource of controller

Inferiority in cache miss performance can degrade the performance by an order of digit (tenfold) or more as compared with that in cache hit performance. Furthermore, conflict factors (e.g. device path, logical volume) magnifies that.

[0052]

Fundamentally, the performance of disk arrays should be statistically computed but this is difficult. Therefore, alternative techniques are used. One of such techniques is such that: the hit rate is set to 50% or so. (It cannot be predicted whether cache hit or cache miss occurs.) The performance value with a logical volume conflict and the performance value without a logical volume conflict are determined, and the virtual I/O response value is computed from these values. FIG. 9 illustrates an example of this computation. In FIG. 9, it is assumed that x=10, y=5, and z=2.

[0053]

Simultaneous allocation of logical volumes 30 in the identical logical volume groups 1 to 4 is made less prone to occur as mentioned above. FIG. 10 is a flowchart illustrating the process of volume allocation. At Step 1, the job management portion 36 creates an allocation candidate list 37. More specifically, the job management portion 36 creates the allocation candidate list 37 based on nonspecific volumes 50 to be used in job steps a, b, and c of jobs 42 and 43. For example, VOL1 to VOL10 are set in the allocation candidate list 37.

[0054]

At Step 2, the job management portion 36 judges whether the listed candidate belong to a disk array system. If not, the operation proceeds to Step 3, and conventional processing is performed. More specifically, only allocated volumes are set in the allocated list 38, and a volume having the lowest I/O response value is selected. Then, the operation proceeds to Step 7.

[0055]

If the listed candidates belong to a disk array system, at Step 4, the constitution information acquiring portion 36A of the job management portion 36 acquires logical volume constitution information from the I/O constitution managing portion 41 with respect to each allocated volume. Next, at Step 4, the setting portion 36B of the job management portion 36 sets the allocated volume and the other logical volumes 30 in the logical volume group 1 to 4 to which the allocated volume belongs in the allocated list 38. This is done based

on the allocation candidate list 37 and the acquired logical volume constitution information. For example, VOL1 to VOL4 are set in the allocated list 38 as illustrated in FIG. 3 with respect to the allocated list 38.

[0056]

At Step 5, the volume selecting portion 39 refers to the allocation candidate list 37 and the allocated list 38 to acquire logical volume constitution information from the I/O constitution managing portion 41. Further, the volume selecting portion 39 acquires performance information from the performance information gathering portion 40, and selects a logical volume 30 achieving the minimum I/O response. In this case, the volume selecting portion 39 acquires a virtual I/O response value computed by the computing portion 40A of the performance information gathering portion 40, and adds the value to the selected logical volume 30. Further, the volume selecting portion 39 also adds a virtual I/O response value to the other logical volumes 30 in the logical volume groups 1 to 4 to which the selected logical volume 30 belongs.

[0057]

With respect to added virtual I/O response values, for example, "10" is added to allocated non-disk array volumes, and "10" is added to allocated disk array volumes. Further, "7" is added to the other volumes unallocated in the logical volume group to which the allocated disk array volume. If a difference is made in priority in allocation between disk array volumes and non-disk array volumes, for example,

virtual I/O response values are added as follows: "10" is added to allocated non-disk array volumes, "5" is added to allocated disk array volumes. Further, "2" is added to the other volumes unallocated in the logical volume group to which the allocated disk array volume belongs.

[0058]

Here, allocation processing wherein a virtual I/O response value is not added when a volume having the lowest I/O response value is selected at Step 6 will be described. FIG. 15 is a flowchart illustrating allocation processing without addition of virtual I/O response values. In FIG. 11, at Step 21, the logical volume constitution information 46 illustrated in FIG. 4(A) is referred to. Then, VOL1 is selected as a volume having the lowest I/O load from among the logical volumes 30 in the logical volume groups 1 to 4 which meet required space size.

[0059]

As illustrated in FIG. 4(B), VOL1 and the other volumes VOL2, VOL3, and VOL4 in the logical volume group 1 to which VOL1 belongs are classified under volume group 47 excluded from allocation and set in the allocated list 38. As the next logical volume constitution information 46, allocation candidate volume group 48 under which the logical volume groups 2, 3, and 4 are classified is acquired.

[0060]

At Step 22, VOL9 is selected as a volume having the lowest I/O load from the allocation candidate volume group 48 illustrated in FIG. 4(B) and allocated. As a result, the

logical volume groups 1 and 3 are classified under volume group 47 excluded allocation as illustrated in FIG. 4(C). The logical volume groups 2 and 4 are classified under allocation candidate volume group 48. At Step 23, VOL5 is selected as a volume having the lowest I/O load from the allocation candidate volume group 48 illustrated in FIG. 4(C) and allocated. As a result, the logical volume groups 1, 2, and 3 are classified under volume group 47 excluded allocation as illustrated in FIG. 5(A). The logical volume group 4 is classified under allocation candidate volume group 48.

[0061]

At Step 24, VOLD is selected as a volume having the lowest load from among the volumes remaining under allocation candidate volume group 48 in FIG. 5(A) and allocated. As a result, VOL1, VOL5, VOL9, and VOLD are classified under volume 49 excluded from allocation as illustrated in FIG. 5(B). The logical volume group 1 without VOL1, the logical volume group 2 without VOL5, the logical volume group 3 without VOL9, and the logical volume group 4 without VOLD are classified under allocation candidate volume group 48. If the relevant logical volumes 30 in the logical volume groups 1 to 4 have been allocated and a round has been completed with respect to the job steps concerned at Step 25, only the actually allocated logical volumes 30 are excluded from allocation. Thus, logical volumes 30 having the lowest I/O response value in the logical volume groups 1 to 4 are allocated in succession again.

[0062]

Eventually, the 16 logical volumes 30 are classified under volume 49 excluded from allocation. As mentioned above, conventionally, only allocated volumes are excluded from allocation. In this embodiment, the other logical volumes 30 in the logical volume groups 1 to 4 to which the allocated volumes belong are also excluded from allocation. Thus, a conflict of accessing within a logical volume group is avoided.

[0063]

FIG. 12 is a flowchart illustrating volume allocation with addition of virtual I/O response values. In FIG. 12, at Step 31, the logical volume constitution information 46 illustrated in FIG. 6(A) is referred to. Then, VOL1 is selected as a volume having the lowest I/O load from among the logical volumes 30 in the logical volume groups 1 to 4 which meet required space size. Then, virtual I/O response values are added to the allocated volume VOL1 and the other volumes VOL2 to VOL4 in the logical volume group 1. With respect to virtual I/O response value, for example, 10ms is added to VOL1 and 7ms is added to VOL2, VOL3, and VOL4.

[0064]

As illustrated in FIG. 6(B), the logical volume group 1 consisting of VOL1 to VOL4 is classified under volume group 47 excluded from allocation and set in the allocated list 38. Allocation candidate volume group 48 under which the logical volume groups 2, 3, and 4 are classified is acquired as logical volume constitution information 46. At Step 32,

VOL9 is selected as a volume having the lowest I/O load from the allocation candidate volume group 48 illustrated in FIG. 6(B) and allocated. Then, virtual I/O response values are added to the allocated volume VOL9 and the other volumes VOLA, VOLB, and VOLC in the logical volume group 3. With respect to virtual I/O response value, for example, 10ms is added to VOL9, and 7ms is added to VOLA, VOLB, and VOLC.

[0065]

As a result, the logical volume groups 1 and 3 are classified under volume group 47 excluded from allocation as illustrated in FIG. 6(C). The logical volume groups 2 and 4 are classified under allocation candidate volume group 48. At Step 33, VOL5 is selected as a volume having the lowest I/O load from the allocation candidate volume group 48 in the FIG. 6(C) and allocated. Then, virtual I/O response values are added to the allocated volume VOL5 and the other volumes VOL6, VOL7, and VOL8 in the logical volume group 2. With respect to virtual I/O response value, for example, 10ms is added to VOL5, and 7ms is added to VOL6, VOL7, and VOL8.

[0066]

As a result, the logical volume groups 1, 2, and 3 are classified under volume group 47 excluded allocation as illustrated in FIG. 7(A). The logical volume group 4 is classified under allocation candidate volume group 48. At Step 34, VOLD is selected as a volume having the lowest I/O load from among the volumes remaining under allocation candidate volume group 48 in FIG. 7(A) and allocated. Then, virtual I/O response values are added to the allocated volume

VOLD and the other volumes VOLE, VOLF, and VOL0 in the logical volume group 4. With respect to virtual I/O response value, for example, 10ms is added to VOLD, and 7ms is added to VOLE, VOLF, and VOL0.

[0067]

As a result, VOL1, VOL5, VOL9, and VOLD are classified under volume 49 excluded from allocation as illustrated in FIG. 7(B). The logical volume group 1 without VOL1, the logical volume group 2 without VOL5, the logical volume group 3 without VOL9, and the logical volume group 4 without VOLD are classified under allocation candidate volume group 48.

[0068]

If the relevant logical volumes 30 in the logical volume groups 1 to 4 have been allocated and a round has been completed with respect to the job steps concerned at Step 35, only the actually allocated logical volumes 30 are excluded from allocation. Thus, logical volumes 30 having the lowest I/O response value in the logical volume groups 1 to 4 are allocated in succession again. Eventually, the 16 logical volumes 30 are classified under volume 49 excluded from allocation.

[0069]

The operation goes back to Step 7 in FIG. 10, and allocation processing is performed on the selected volumes in response to a space request. At Step 8, it is judged whether the space has been successfully obtained. If not, the operation goes back to Step 2, and the next volume allocation is carried out. If the space is successfully obtained and, for example, the 16 volumes are allocated, the processing is terminated.

Conventionally, only allocated volumes are excluded from allocation. In this embodiment, the other logical volumes 30 in the logical volume groups 1 to 4 to which the allocated volumes belong are also excluded from allocation. Thus, a logical volume conflict within the identical logical volume groups 1 to 4 can be avoided.

[0070]

The numeric values of (1) to (16) in FIG. 8 indicate the order of allocation. As can be seen from the figure, a conflict of I/O accessing is less prone to occur in the logical volume groups 1 and 2. In consideration of any coexistence of devices, different in access performance, in a nonspecific volume, a virtual I/O response value indexing the I/O access performance is added and incorporated in allocation. Then, the virtual I/O response value is made different between non-disk array volumes and disk array volumes. Thus, disk array volumes and non-disk array volumes are not overlappingly used similarly.

[0071]

Further, to make simultaneous allocation of logical volumes 30 less prone to occur in the identical logical volume groups 1 to 4, virtual I/O response values are also added to the other logical volumes 30 in the logical volume groups 1 to 4 to which the allocated volumes belong. Since volume allocation is optimized as mentioned above, the response to volume accesses and the throughput can be improved.

[0072]

In this embodiment, information on the constitution on

devices, such as presence/absence of logical volume division and the construction of enclosure (whether to be controlled under the same device adaptor or not) is acquired with respect to I/O access performance. Therefore, even if any device is added or removed, that can be reflected in allocation with ease.

[0073]

[Effects of the Invention]

As mentioned up to this point, according to the present invention, volume allocation can be optimized. Thus, the response to volume accesses and the throughput can be improved.

[Brief Explanation of the Drawings]

FIG. 1: Drawing illustrating the principle of the present invention.

FIG. 2: Block diagram illustrating an embodiment of the present invention.

FIG. 3: Drawing illustrating an example of the constitution of a volume allocating program.

FIG. 4: Drawing illustrating volume allocation without addition of virtual I/O response values (1/2).

FIG. 5: Drawing illustrating volume allocation without addition of virtual I/O response values (2/2).

FIG. 6: Drawing illustrating volume allocation with addition of virtual I/O response values (1/2).

FIG. 7: Drawing illustrating volume allocation with addition of virtual I/O response values (2/2).

FIG. 8: Drawing explaining the order of allocation.

FIG. 9: Drawing illustrating an example of virtual I/O response values.

FIG. 10: Flowchart illustrating the process of volume allocation.

FIG. 11: Flowchart illustrating selection of minimum volume without addition of virtual I/O response values.

FIG. 12: Flowchart illustrating selection of minimum volume with addition of virtual I/O response values.

FIG. 13: Block diagram illustrating an example of prior art.

FIG. 14: Drawing illustrating a conventional volume allocating program.

FIG. 15: Flowchart illustrating conventional volume allocation.

[Explanation of Reference Numerals]

1 - 4: Logical volume group

21: Host computer

22, 23: Channel

24, 25, 28: Path

26: Input/output controller

27: Volume allocating program

29: Disk array

30: Logical volume

31 - 34: Data disk

35: Parity disk

36: Job management portion

36A: Constitution information acquiring portion (constitution information acquiring means)

36B: Setting portion (setting means)

37: Allocation candidate list

38: Allocated list

39: Volume selecting portion

39A: Adding portion

40: Performance information gathering portion (performance information gathering means)

40A: Computing portion

41: I/O constitution information managing portion (I/O constitution information managing means)

42, 43: Job

44: Input/output device

45: Selected volume

46: Logical volume constitution information

47: Volume group excluded from allocation

48: Allocation candidate volume group

49: Volume excluded from allocation

50: Nonspecific volume

FIG. 1:

本発明の原理説明図 Drawing Illustrating Principle of Present Invention

36A/ Constitution information acquiring means

36B/ Setting means

37/ Allocation candidate list

38/ Allocated list

39/ Volume selecting means

40/ Performance information gathering means

41/ I/O constitution information managing means

FIG. 2:

本発明の一実施形態を示すブロック図 Block Diagram Illustrating Embodiment of Present Invention

1/ Logical volume group

21/ Host computer

22, 23/ Channel

26/ Input/output controller

27/ Volume allocating program

29/ Disk array

30/ Logical volume

FIG. 3:

ボリューム割当てプログラムの構成例を示す図 Drawing Illustrating Example of Constitution of Volume Allocating Program

27/ Volume allocating program

36/ Job management portion

36A/ Constitution information acquiring portion

36B/ Setting portion

37/ Allocation candidate list

38/ Allocated list

39/ Volume selecting portion

39A/ Setting portion

40/ Performance information gathering portion

40A/ Computing portion

41/ I/O constitution information managing portion

42, 43/ Job

ジョブステップ - Job step -

45/ Selected volume

FIG. 4:

仮想 I/O レスポンス値を加算しないボリューム割当ての説明図（その一）

Drawings Illustrating Volume Allocation without Addition of Virtual I/O Response Value (1/2)

論理ボリュームグループ - Logical volume group -

47/ Volume group excluded from allocation

48/ Allocation candidate volume group

FIG. 5:

仮想 I/O レスポンス値を加算しないボリューム割当ての説明図（その二）

Drawings Illustrating Volume Allocation without Addition of Virtual I/O Response Value (2/2)

論理ボリュームグループ - Logical volume group -

47/ Volume group excluded from allocation

48/ Allocation candidate volume group

49/ Volume excluded from allocation

FIG. 6:

仮想 I/O レスポンス値を加算したボリューム割当ての説明図（その一）

Drawings Illustrating Volume Allocation with Addition of Virtual I/O Response Value (1/2)

論理ボリュームグループ - Logical volume group -

47/ Volume group excluded from allocation

48/ Allocation candidate volume group

FIG. 7:

仮想 I/O レスポンス値を加算したボリューム割当ての説明図（その二）

Drawings Illustrating Volume Allocation with Addition of Virtual I/O Response Value (2/2)

論理ボリュームグループ - Logical volume group -

47/ Volume group excluded from allocation

48/ Allocation candidate volume group

49/ Volume excluded from allocation

FIG. 8:

割当て順序の説明図 Drawing Explaining Order of Allocation

21/ Host computer

22, 23/ Channel

26, 105/ Input/output controller

27/ Volume allocating program

29/ Disk array

50/ Nonspecific volume

FIG. 9:

仮想 I/O レスポンス値の例を示す図　Drawing Illustrating Example of Virtual I/O Response Value

項目　Item

I/O レスポンス比率　I/O response ratio

非ディスクアレイ　Non-disk array volume

ディクスアレイ　Disk array volume

（同一論理ボリュームグループ競合なし）　(Without conflict in identical logical volume group)

キャッシュヒット 50%を想定　Assumed cache hit rate: 50%

（同一論理ボリュームグループ競合あり）　(With conflict in identical logical volume group)

FIG. 10:

ボリューム割当ての処理を説明するフローチャート　Flowchart Illustrating Process of Volume Allocation

開始　Start

S1/ Create allocation candidate list

S2/ Disk array system?

S3/ (Conventional processing) Set only allocated volume and select volume achieving minimum I/O response

S4/ Acquire logical volume constitution information with respect to each allocated volume

S5/ Set allocated volume including logical volume information in allocated list

S6/ Select volume achieving minimum I/O response

S7/ Allocate selected volume

S8/ Space successfully obtained?

終了　End

FIG. 11:

仮想 I/O レスポンス値を加算しない場合の最小ボリューム選択を説明するフローチャート　Flowchart Illustrating Selection of Minimum Volume without Addition of Virtual I/O Response Value

ステップ S5 より　From Step 5

S21/ Select volume having lowest I/O load from volume group which meets required space size and allocate it ⇒ VOL1

S22/ Select volume having lowest I/O load from allocation candidate volume group and allocate it ⇒ VOL9

S23/ Select volume having lowest I/O load from allocation candidate volume group and allocate it ⇒ VOL5

S24/ Select volume having lowest I/O load from among volumes remaining in allocation candidate volume group and allocate it ⇒ VOLD

S25/ If relevant logical volumes in logical volume groups have been allocated and a round has been completed with respect to job steps concerned, exclude only actually allocated logical volumes and allocate volume achieving lowest I/O response value in logical volume groups in succession again

ステップ S7 へ To Step 7

FIG. 12:

仮想 I/O レスポンス値を加算した場合の最小ボリューム選択を説明するフローチャート　Flowchart Illustrating Selection of Minimum Volume with Addition of Virtual I/O Response Value

ステップ S5 より　From Step 5

S31/ Select volume having lowest I/O load from volume groups which meet required space size and allocate it ⇒ VOL1
Add virtual I/O response values to allocated logical volume group 1
Add 10ms to VOL1 and 7ms to VOL2, VOL3, and VOL4
S32/ Select volume having lowest I/O load from allocation candidate volume group and allocate it ⇒ VOL9
Add virtual I/O response values to allocated logical volume group 3
Add 10ms to VOL9 and 7ms to VOLA, VOLB, and VOLC
S33/ Select volume having lowest I/O load from allocation candidate volume group and allocate it ⇒ VOL5
Add virtual I/O response values to allocated logical volume group 2
Add 10ms to VOL5 and 7ms to VOL6, VOL7, and VOL8
S34/ Select volume having lowest I/O load from volumes remaining in allocation candidate volume group ⇒ VOLD
Add virtual I/O response values to allocated logical volume group 4
Add 10ms to VODL and 7ms to VOLE, VOLF, and VOL0
S35/ If relevant logical volumes in logical volume groups have been allocated and a round has been completed with respect to job steps concerned, exclude only actually allocated logical volumes and allocate volume achieving lowest I/O response value in logical volume groups in succession again
ステップS7へ To Step 7

FIG. 13:

従来例を示すブロック図　Block Diagram Illustrating Example of Prior Art

101/ Host computer

101A/ Volume allocating program

102, 103/ Channel

104, 105/ Input/output controller

110/ Disk array

114/ Nonspecific volume

FIG. 14:

従来のボリューム割当てプログラムを示す図　Drawing Illustrating Conventional Volume Allocating Program

101A/ Volume allocating program

115/ Job management portion

116/ Allocation candidate list

117/ Allocated list

118/ Volume selecting portion

119/ Performance information gathering portion

121/ Selected volume

122, 123/ Job

ジョブステップ -　Job step -

FIG. 15:

従来のボリューム割当てを説明するフローチャート　Flowchart Illustrating Conventional Volume Allocation

開始　Start

S101/ Create allocation candidate list

S102/ Set only allocated volumes in allocated list

S103/ Select volume achieving minimum I/O response value

S104/ Allocate selected volume

S105/ Space successfully obtained?

終了 End